PB-240 507

WAGONGA LAKE, KANDIYOHI COUNTY, MINNESOTA

Pacific Northwest Environmental Research Laboratory

Prepared for:

National Environmental Research Center
Minnesota Pollution Control Agency
Minnesota National Guard

November 1974

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16. ABSTRACT
Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
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REPORT
ON
WAGONGA LAKE
KANDIYOHI COUNTY
MINNESOTA

EPA REGION V

WORKING PAPER No. 133

WITH THE COOPERATION OF THE

MINNESOTA POLLUTION CONTROL AGENCY

AND THE

MINNESOTA NATIONAL GUARD

NOVEMBER, 1974

II

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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to fresh water lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Minnesota Pollution Control Agency for professional involvement and to the Minnesota National Guard for conducting the tributary sampling phase of the Survey.

Grant J. Merritt, Director of the Minnesota Pollution Control Agency, John F. McGuire, Chief, and Joel G. Schilling, Biologist, of the Section of Surface and Groundwater, Division of Water Quality, provided invaluable lake documentation and counsel during the course of the Survey; and the staff of the Section of Municipal Works, Division of Water Quality, were most helpful in identifying point sources and soliciting municipal participation in the Survey.

Major General Chester J. Moeglein, the Adjutant General of Minnesota, and Project Officer Major Adrian Beltrand, who directed the volunteer efforts of the Minnesota National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

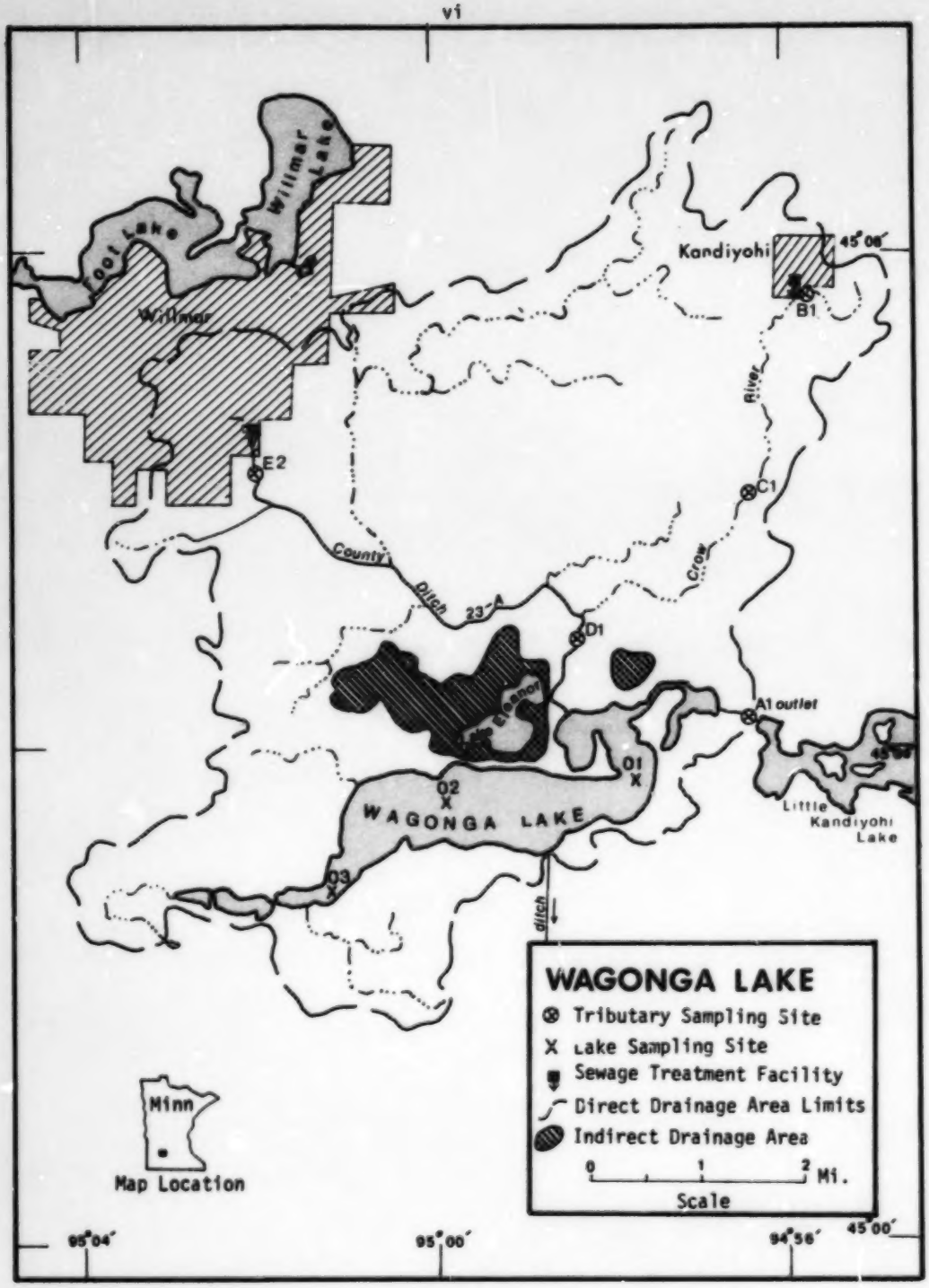
NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF MINNESOTA

LAKE NAME	COUNTY
Albert Lea	Freeborn
Andrusia	Beltrami
Badger	Polk
Bartlett	Koochiching
Bear	Freeborn
Bemidji	Beltrami
Big	Stearns
Big Stone	Big Stone, MN; Roberts, Grant, SD
Birch	Cass
Blackduck	Beltrami
Blackhoof	Crow Wing
Budd	Martin
Buffalo	Wright
Calhoun	Hennepin
Carlos	Douglas
Carrigan	Wright
Cass	Beltrami, Cass
Clearwater	Wright, Stearns
Cokato	Wright
Cranberry	Crow Wing
Darling	Douglas
Elbow	St. Louis
Embarass	St. Louis
Fall	Lake
Forest	Washington
Green	Kandiyohi
Gull	Cass
Heron	Jackson
Leech	Cass
Le Homme Dieu	Douglas
Lily	Blue Earth
Little	Grant
Lost	St. Louis

LAKE NAME	COUNTY
Madison	Blue Earth
Malmedal	Pope
Mashkenode	St. Louis
McQuade	St. Louis
Minnetonka	Hennepin
Minnewaska	Pope
Mud	Itasca
Nest	Kandiyohi
Pelican	St. Louis
Pepin	Goodhue, Wabasha, MN; Pierce, Pepin, WI
Rabbit	Crow Wing
Sakatah	Le Sueur
Shagawa	St. Louis
Silver	McLeod
Six Mile	St. Louis
Spring	Washington, Dakota
St. Croix	Washington, MN; St. Croix, Pierce, WI
St. Louis Bay	St. Louis, MN; Douglas, WI
Superior Bay	St. Louis, MN; Douglas, WI
Swan	Itasca
Trace	Todd
Trout	Itasca
Wagonga	Kandiyohi
Wallmark	Chisago
White Bear	Washington
Winona	Douglas
Wolf	Beltrami, Hubbard
Woodcock	Kandiyohi
Zumbro	Olmstead, Wabasha


Willmar Lake
Cool Lake
Willmar
Kandiyohi
45°06′
B1
River
E2
C1
County
Ditch
23-A
Crow
D1
Eleanor
A1 outlet
01
02
WAGONGA LAKE
Little
Kandiyohi
Lake
03
ditch
WAGONGA LAKE
Tributary Sampling Site
Lake Sampling Site
Sewage Treatment Facility
Direct Drainage Area Limits
Indirect Drainage Area
0
1
2
Mi.
Scale
Minn
Map Location
95°04′
95°00′
94°56′
45°00′

WAGONGA LAKE

STORET NO. 2781

I. CONCLUSIONS

A. Trophic Condition:

Survey data and the records of others show that Wagonga Lake is eutrophic. Survey limnologists noted the lake had a "pea-soup" appearance at all sampling visits and reported an "enormous" bloom decomposing in late August, 1972.

Of the 60 Minnesota lakes sampled in the fall when essentially all were well-mixed, 54 had less mean total phosphorus, and dissolved phosphorus, and 43 had less mean inorganic nitrogen. For all 80 lakes sampled, 87% had less mean chlorophyll *a*, and 87% had greater mean Secchi disc transparency.

B. Rate-Limiting Nutrient:

A significant loss of nutrients occurred in the algal assay sample between the time of collection and the beginning of the assay, and the results are not reliable. However, the lake data show nitrogen limitation at all sampling times (N/P ratios were less than 1/1 on all occasions).

C. Nutrient Controllability:

1. Point sources--During the sampling year, it is calculated that Wagonga Lake received a total phosphorus load at a rate about 20 times the rate proposed by Vollenweider (in press) as "dangerous"; i.e., a eutrophic rate (see page 12). Of this load, it is estimated

that the City of Willmar contributed about 92% and the Village of Kandiyohi about 1%.

It is calculated that even complete removal of phosphorus at the indicated point sources would result in a loading rate of 2.2 lbs/acre/yr or 0.25 $g/m^2/yr$--a rate still in excess of the eutrophic rate of 0.20 $g/m^2/yr$. However, if such a degree of removal can be achieved, it is concluded that the incidence and severity of algal blooms in Wagonga Lake would be reduced; and, more important, the occurrence of toxic algal blooms in downstream Big Kandiyohi Lake (Anonymous, 1971) would be reduced.

2. Non-point sources--The nutrient loads attributed to County Ditch 23-A were estimated since point-source loads exceeded those measured in the Ditch. For this reason, calculated nutrient exports would be of little significance.

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS

A. Lake Morphometry*:

1. Surface area: 1,617 acres.
2. Mean depth: 4.2 feet.
3. Maximum depth: 15 feet.
4. Volume: 6,791 acre/feet.
5. Mean hydraulic retention time: 1.4 years.

B. Tributary and Outlet:
(See Appendix A for flow data)

1. Tributaries -

Name	Drainage area†	Mean flow†
County Ditch 23-A	17.2 mi^2	4.5 cfs
Minor tributaries & immediate drainage -	5.7 mi^2	2.3 cfs
Totals	22.9 mi^2	6.8 cfs

2. Outlet -

(to Little Kandiyohi Lake)	25.5 mi^{2}††	6.8 cfs

C. Precipitation†††:

1. Year of sampling: 27.0 inches.
2. Mean annual: 24.5 inches.

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* DNR lake survey map (1966); mean depth by random dot method.
† Drainage areas are accurate within ±5%; mean daily flows are accurate within ±10%; and ungaged flows are accurate within ±10 to 25% for drainage areas greater than 10 mi^2.
†† Includes area of lake.
††† See Working Paper No. 1, "Survey Methods".

III. LAKE WATER QUALITY SUMMARY

Wagonga Lake was sampled three times during the open-water season of 1972 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from one or more depths at three stations on the lake (see map, page vi). During each visit, a single depth-integrated (near bottom to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during the last visit, a single five-gallon depth-integrated sample was composited for algal assays. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll a analysis. The maximum depths sampled were 4 feet at station 1, 8 feet at station 2, and 5 feet at station 3.

The results obtained are presented in full in Appendix B, and the data for the fall sampling period, when the lake was essentially well-mixed, are summarized below. Note, however, the Secchi disc summary is based on all values.

For differences in the various parameters at the other sampling times, refer to Appendix B.

A. Physical and chemical characteristics:

Parameter	Minimum	Mean	Median	Maximum
		FALL VALUES (10/25/72)		
Temperature (Cent.)	4.5	4.6	4.5	4.8
Dissolved oxygen (mg/l)	10.4	11.0	11.2	11.4
Conductivity (μmhos)	825	838	838	850
pH (units)	9.1	9.2	9.2	9.2
Alkalinity (mg/l)	210	219	220	220
Total P (mg/l)	1.000	1.093	1.090	1.200
Dissolved P (mg/l)	0.770	0.834	0.820	0.930
NO_2 + NO_3 (mg/l)	0.140	0.233	0.200	0.370
Ammonia (mg/l)	0.270	0.369	0.330	0.510
		ALL VALUES		
Secchi disc (inches)	6	12	12	15

B. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Number per ml
07/02/72	1. Oscillatoria	42,727
	2. Anabaena	8,333
	3. Melosira	6,364
	4. Marssoniella	1,060
	5. Stephanodiscus	758
	Other genera	1,667
	Total	60,909
08/31/72	1. Oscillatoria	33,997
	2. Lyngbya	13,020
	3. Anabaena	9,042
	4. Melosira	2,893
	5. Microcystis	2,712
	Other genera	7,594
	Total	69,258
10/25/72	1. Oscillatoria	20,226
	2. Flagellates	2,105
	3. Melosira	1,353
	4. Dinobryon	902
	5. Scenedesmus	677
	Other genera	2,030
	Total	27,293

2. Chlorophyll *a* -
(Because of instrumentation problems during the 1972 sampling, the following values may be in error by plus or minus 20 percent.)

Sampling Date	Station Number	Chlorophyll *a* (µg/l)
07/02/72	01	64.9
	02	179.6
	03	153.9
08/31/72	01	44.4
	02	24.7
	03	29.8
10/25/72	01	196.6
	02	53.8
	03	102.5

IV. NUTRIENT LOADINGS
(See Appendix C for data)

For the determination of nutrient loadings, the Minnesota National Guard collected a monthly near-surface grab sample from each of the tributary sites indicated on the map (page vi) except for the high run-off month of May when two samples were collected. Sampling was begun in October, 1972, and was completed in September, 1973.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Minnesota District Office of the U.S. Geological Survey for the tributary sites nearest the lake.

In this report, nutrient loads for sampled tributaries were determined by using a modification of a U.S. Geological Survey computer program for calculating stream loadings. Nutrient loadings for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were calculated using the mean concentrations in the Crow River at station B-1 and ZZ flows.

The operator of the Willmar wastewater treatment plant provided monthly effluent samples and corresponding flow data; however, the Village of Kandiyohi declined to participate in the Survey, and nutrient loads from that source were estimated at 2.5 lbs P and 7.5 lbs N/capita/year.

During the sampling year, the nutrient loads measured at the Willmar plant exceeded the amounts measured in the inlet stream at station D-1. However, in this report it is assumed that all of the Willmar loads reached

the lake; and in the following loading tables, the areal or non-point-source loads attributed to County Ditch 23-A were calculated by using mean concentrations in the Crow River at station B-1 and flows at D-1 minus the mean Willmar plant flows (3.4 cfs).

A. Waste Sources:

1. Known municipal -

Name	Pop. Served*	Treatment	Mean Flow (mgd)	Receiving Water
Willmar	12,869	Act. sludge	2.218	County Ditch 23-A
Kandiyohi	295	Trickling filter	0.029**	Crow River

2. Known industrial - None

* Anonymous, 1973.
** Estimated at 100 gal/capita/day.

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	lbs P/ yr	% of total
a. Tributaries (non-point load) -		
County Ditch 23-A	1,110	1.9
b. Minor tributaries & immediate drainage (non-point load) -	2,270	3.9
c. Known municipal -		
Willmar	53,280	92.4
Kandiyohi	740	1.3
d. Septic tanks - Unknown	-	-
e. Known industrial - None	-	-
f. Direct precipitation* -	250	0.4
Total	57,650	100.0

2. Outputs -

Lake outlet (to Little Kandiyohi Lake)	24,690

3. Net annual P accumulation - 32,960 pounds

* See Working Paper No. 1.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	lbs N/ yr	% of total
a. Tributaries (non-point load) -		
County Ditch 23-A	7,360	3.2
b. Minor tributaries & immediate drainage (non-point load) -	14,970	6.5
c. Known municipal -		
Willmar	171,240	74.1
Kandiyohi	22,010	9.5
d. Septic tanks - Unknown	-	-
e. Known industrial - None	-	-
f. Direct precipitation* -	15,580	6.7
Total	231,160	100.0

2. Outputs -

Lake outlet (to Little Kandiyohi Lake)	76,820

3. Net annual N accumulation - 154,340 pounds

* See Working Paper No. 1.

D. Yearly Loading Rates:

In the following table, the existing phosphorus loading rates are compared to those proposed by Vollenweider (in press). Essentially, his "dangerous" rate is the rate at which the receiving waters would become eutrophic or remain eutrophic; his "permissible" rate is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic rate would be considered one between "dangerous" and "permissible".

	Total Phosphorus		Total Nitrogen	
Units	Total	Accumulated	Total	Accumulated
lbs/acre/yr	35.7	20.4	143.0	95.4
grams/m^2/yr	4.00	2.28	16.0	10.7

Vollenweider loading rates for phosphorus ($g/m^2/yr$) based on mean depth and mean hydraulic retention time of Wagonga Lake:

"Dangerous" (eutrophic rate)	0.20
"Permissible" (oligotrophic rate)	0.10

V. LITERATURE REVIEWED

Anonymous, 1971. Report on investigation of water quality of Wagonga and Big Kandiyohi lakes system, Kandiyohi County. MPCA, Minneapolis.

Anonymous, 1973. Wastewater disposal facilities inventory. MPCA, Minneapolis.

Schilling, Joel, 1974. Personal communication (lake map). MPCA, Minneapolis.

Vollenweider, Richard A., (in press). Input-output models. Schweiz. A. Hydrol.

VII. APPENDICES

APPENDIX A

TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR MINNESOTA 10/30/74

LAKE CODE 2741 WAGONGA LAKE

TOTAL DRAINAGE AREA OF LAKE 25.50

TRIBUTARY	SUB-DRAINAGE AREA	NORMALIZED FLOWS JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
274141	25.51	1.32	1.42	4.93	12.97	14.72	19.85	10.23	4.48	3.87	2.98	2.21	1.77	6.83
274101	17.20	0.96	0.96	3.72	8.47	10.98	12.40	6.72	2.80	2.55	1.83	1.36	1.20	4.53
274177	4.24	0.77	0.64	2.29	3.82	5.38	6.20	3.30	1.37	1.38	0.93	0.65	0.80	2.30

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 25.50
SUM OF SUB-DRAINAGE AREAS = 25.45

TOTAL FLOW IN = 81.76
TOTAL FLOW OUT = 81.77

MEAN MONTHLY FLOWS AND DAILY FLOWS

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
274141	10	72	7.74	15	7.30				
	11	72	9.34	5	8.70				
	12	72	4.05	9	5.60				
	1	73	4.69	6	4.70				
	2	73	3.84	4	4.10				
	3	73	10.90	10	11.00				
	4	73	22.70	14	23.00				
	5	73	14.23	6	14.80	19	17.00		
	6	73	12.20	16	10.00				
	7	73	2.43	14	3.40				
	8	73	3.40	11	3.83				
	9	73	1.99	6	3.34				
274101	10	72	4.95	15	4.60				
	11	72	5.86	5	5.40				
	12	72	3.44	9	3.90				
	1	73	3.47						
	2	73	2.63	4	2.80				
	3	73	14.70	10	8.80				
	4	73	15.00	14	15.00				
	5	73	12.50	6	12.00	19	11.00		
	6	73	8.32	10	11.00				
	7	73	1.85	14	2.25				
	8	73	2.14	11	1.41				
	9	73	1.33	6	2.25				
274177	10	72	2.51	15	2.40				
	11	72	2.42	5	2.40				
	12	72	2.31	9	2.40				
	1	73	3.41	6	3.40				
	2	73	2.74	4	2.93				
	3	73	3.95	10	2.40				
	4	73	6.76	14	6.80				
	5	73	5.83	6	5.70	19	5.40		
	6	73	4.03	10	5.10				
	7	73	0.96	14	1.11				
	8	73	1.05	11	0.93				
	9	73	0.77	6	1.22				

19

APPENDIX B

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 74/10/30

270101
45 48 45.0 094 57 45.0
WAGONGA LAKE
27 MINNESOTA

11EPALES
3

2111202
0004 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/07/02	14 00	0000	23.0	7.8	14	750	8.70	224	0.140	0.100	0.462	0.345
72/08/31	12 15	0000			6	880	9.00	206	0.140	0.180	1.070	0.710
	12 15	0003	20.5	9.8		820	9.00	224	0.160	0.170	1.060	0.695
72/10/25	13 25	0000			10	850	9.10	220	0.370	0.300	1.200	0.930
	13 25	0004	4.6	11.2		850	9.10	220	0.340	0.270	1.180	0.890

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/07/02	14 00	0000	64.9J
72/08/31	12 15	0000	44.4J
72/10/25	13 25	0000	196.6J

J VALUE KNOWN TO BE IN ERROR

STORET RETRIEVAL DATE 74/10/30

278102
45 48 30.0 094 59 57.0
WAGONGA LAKE
27 MINNESOTA

11EPALES 2111202
3 0009 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/07/02	14 15	0000	23.0	7.2	15	775	8.90	280	0.100	0.090	0.466	0.341
72/08/31	12 25	0000			12	800	8.93	204	0.170	0.170	0.935	0.645
	12 25	0004	20.6	8.2		795	8.91	208	0.160	0.280	0.945	0.655
	12 25	0006	20.6	8.4		800	8.92	203	0.180	0.350	0.935	0.740
72/10/25	13 45	0000			10	825	9.20	220	0.200	0.330	1.090	0.830
	13 45	0004	4.5	10.4		825	9.20	220	0.180	0.300	1.090	0.820
	13 45	0008	4.5	11.4		825	9.20	210	0.200	0.310	1.080	0.820

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/07/02	14 15	0000	179.6J
72/08/31	12 25	0000	24.7J
72/10/25	13 45	0000	53.8J

J VALUE KNOWN TO BE IN ERROR

STORET RETRIEVAL DATE 74/10/30

278103
45 03 03.0 095 01 00.0
WAGONGA LAKE
27 MINNESOTA

11EPALES
3

2111202
0006 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/07/02	14 30	0000	23.5	8.8	14	775	8.90	274	0.060	0.050	0.586	0.501
72/08/31	12 40	0000			8	795	9.00	203	0.170	0.350	0.935	0.620
	12 40	0005	20.9	10.0		800	9.00	206	0.170	0.200	0.935	0.625
72/10/25	14 00	0000			15	850	9.20	220	0.140	0.480	1.000	0.780
	14 00	0004	4.8	11.2				220	0.200	0.510	1.010	0.770

61

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/07/02	14 30	0000	153.9J
72/08/31	12 40	0000	29.8J
72/10/25	14 00	0000	102.5J

J VALUE KNOWN TO BE IN ERROR

APPENDIX C

TRIBUTARY and WASTEWATER TREATMENT PLANT DATA

STORET RETRIEVAL DATE 74/10/30

27H1A1 LS27H1A1
45 04 00.0 094 56 30.0
#AGONGA LK/LITTLE KANDIYOHI CONN
27163 15 ATWATER
O/#AGONGA LAKE
CO HWY XING 4 MI S OF KANDIYOHI
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/10/15	13 40		0.470	4.600	1.200	0.240	1.470
72/11/05	09 00		0.740	3.990	0.240	0.700	7.300
72/12/09	11 30		0.790	3.490	0.750	1.400	1.540
73/01/06	13 50		0.360	5.400	2.500	2.100	2.200
73/02/04	12 20		1.300	5.500	0.995	1.740	1.900
73/03/10	09 45		0.200	4.600	1.700	1.950	2.200
73/04/14	13 25		0.019		0.070	0.690	1.650
73/05/06	14 15		0.028	4.100	0.023	0.340	
73/05/19	11 05		0.011	4.900	0.028	0.140	0.690
73/06/10	11 30		0.010K	4.700	0.044	0.575	1.000
73/07/14	15 10		0.019	9.100	0.120	0.850	1.450
73/08/11	13 30		0.010K		0.074	0.430	0.980
73/09/06	19 00		0.042	6.300	0.033	0.200	0.580

K VALUE KNOWN TO BE LESS THAN INDICATED

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STORET RETRIEVAL DATE 74/10/30

27R1H1 LS27B1B1
45 0R 00.0 094 56 00.0
UNNAMED STRM KANDIYOHI TO LK
27 15 ATWATER
T/WAGONGA
KING S EDGE OF KANDIYOHI ABOVE STP
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/10/15	13 30		0.287	2.000	0.215	0.280	0.336
72/11/05	08 40		0.770	1.890	0.290	0.390	0.710
73/03/10	09 30		1.440	3.890	1.160	0.927	1.100
73/04/14	13 10		0.198	2.520	0.032	0.160	0.230
73/05/06	13 00		0.140	1.700	0.012	0.300	0.345
73/05/19	09 40		0.044	1.890	0.023	0.132	0.245
73/06/10	11 00		0.072	3.700	0.220	0.840	1.000
73/07/14	13 00		0.030	3.450	0.056	0.160	0.290
73/08/11	11 50		0.010K		0.052	0.110	0.345
73/09/06	20 30		0.740	5.900	0.680	0.105	0.410

K VALUE KNOWN TO BE LESS THAN INDICATED

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STORET RETRIEVAL DATE 74/10/30

27BICI LS27BICI
45 06 00.0 094 56 30.0
UNNAMED STRM KANDIYOHI TO LK
27 15 ATWATER
T/WAGONGA LAKE
CO HWY 8 XING S OF KANDIYOHI BELO STP
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/10/15	13	20	4.500	2.900	0.150	0.280	2.000
72/11/05	08	50	2.200	1.400	0.210	0.295	0.845
72/12/09	11	15	2.800	3.240	0.860	2.300	2.400
73/03/10	09	20	1.720	4.100	1.470	1.065	1.250
73/04/14	13	10	1.660	3.400	0.048	0.650	0.750
73/05/06	13	20	1.820	3.700	0.066	0.650	0.700
73/05/19	10	45	1.900	2.000	0.038	0.965	1.100
73/06/10	11	10	4.100	4.700	1.260	2.200	2.200
73/07/14	13	30	2.100	5.100	1.050	2.600	3.200
73/09/11	11	55	3.500	5.200	0.680	2.200	3.100
73/09/04	19	45	3.100	3.530	0.685	3.000	3.300

STORET RETRIEVAL DATE 74/10/30

274101 LS274101
45 05 00.0 094 58 30.0
UNNAMED TRIB TO LK ELEANOR OUTLE
27 15 ATWATER
T/WAGONGA LAKE
CO HWY 88 BRDG NE OF LK ELEANOR
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/10/15	13 50		1.370	2.800	0.580	0.470	1.500
72/11/05	09 15		4.680	2.100	0.390	1.837	
73/02/04	12 30		13.200	3.590	1.400	4.500	5.250
73/03/10	09 10		5.800	4.500	1.700	2.100	2.400
73/04/14	14 00		8.700	2.800	0.210	2.300	2.880
73/05/06	13 45		6.600	3.100	0.270	1.700	1.950
73/05/19	10 25		10.900	2.730	0.378	2.700	3.400
73/06/10	11 15		9.400	2.600	0.320	2.300	2.600
73/07/14	14 25		13.000	2.400	0.400	4.600	5.000
73/08/11	14 00		15.600	3.450	1.280	4.650	5.800
73/09/06	19 20		13.600	5.800	2.600	3.200	4.300

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STORET RETRIEVAL DATE 74/10/30

27N1E2 LS27N1E2
45 06 00.0 095 02 00.0
DITCH S FROM WILMAR
27 7.5 WILMAR
T/WAGONGA LAKE
XING SE EDGE OF WILMAR BELOSTP
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/10/15	14 10		11.000	1.550	0.550	2.525	8.400
72/11/05	09 35		6.600	2.700	1.200	2.100	5.500
72/12/09	11 50		13.700	3.500	0.730	5.325	7.400
73/01/06	14 30		21.000	2.400	0.705	5.880	6.800
73/02/04	13 00		24.000		0.770	7.000	8.100
73/03/10	09 00		16.400	3.900	1.890	4.850	6.800
73/04/14	12 45		27.000	4.100	0.430	6.900	8.100
73/05/06	14 45		23.800	2.600	0.660	5.500	6.000
73/05/19	10 10		14.000	2.400	0.630	4.700	6.700
73/06/10	11 45		23.000	1.550	0.470	6.400	7.300
73/07/14	14 00			1.890	0.370	7.300	9.000
73/08/11	14 45		10.000		10.400	4.600	

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STORET RETRIEVAL DATE 74/10/30

278151 AS278151 P012069
45 06 30.0 095 02 00.0
WILLMAR
27163 7.5 WILLMAR
T/LAKE WAGONGA
UNNAMED DITCH
11EPALES 2141204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
73/01/30	00 00								
CP(T)-			23.000	3.000	0.370	6.100	6.400	2.160	1.870
73/01/31	24 00								
73/02/27	00 00								
CP(T)-			26.000	12.000	0.190	6.600		2.150	2.010
73/02/27	24 00								
73/03/27	00 00								
CP(T)-			21.000	2.500	0.055	5.600	6.800	2.290	2.190
73/03/28	24 00								
73/04/29	00 00								
CP(T)-			25.000	2.900	0.038	6.375	7.000	1.820	2.190
73/04/29	24 00								
73/05/30	00 00								
CP(T)-			20.400	0.100K	0.048	5.100	6.700	2.610	2.350
73/05/30	24 00								
73/06/26	00 00								
CP(T)-			19.600	0.800	0.160	6.200	7.600	2.220	2.200
73/06/26	24 00								
73/07/31	00 00								
CP(T)-			20.000	0.100K	0.064	4.400	8.550	2.310	2.170
73/07/31	24 00								
73/09/04	00 00								
CP(T)-			18.800	4.180				2.310	2.390
73/09/04	24 00								
73/10/04	00 00								
CP(T)-			24.000	4.350	0.140	8.200	8.800	2.700	2.420
73/10/04	24 00								
73/10/30	00 00								
CP(T)-			23.000	2.000	0.120	6.200	9.000	2.910	2.610
73/10/30	24 00								
73/11/29	00 00								
CP(T)-			22.000	0.500K	0.130	6.100	8.400	2.700	2.370
73/11/29	24 00								
73/12/30	12 00								
CP(T)-			32.000	2.100	0.110	7.900	9.300	1.400	1.850
73/12/31	12 00								

K VALUE KNOWN TO BE LESS THAN INDICATED

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STORET RETRIEVAL DATE 74/10/30

278151 AS278151 P012869
45 06 30.0 095 02 00.0
WILLMAR
27163 7.5 WILLMAR
T/LAKE WAGONGA
UNNAMED DITCH
11E-ALES 2141204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
74/01/24	10 00								
CP(T)-			29.430	6.100	0.300	7.700	9.000	1.990	1.840
74/01/24	24 00								

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